CLAIMS

We Claim:

1. A micromirror device, comprising:

a substrate;

a hinge and a hinge support connected to the substrate;

a movable reflective mirror plate, wherein the hinge is attached to the mirror plate at a first location on the mirror plate; and

an extension plate connected to the mirror pate at a second location on the mirror plate.

2. The device of claim 1, wherein the extension plate defines a first gap between the extension plate and the mirror plate; and wherein the extension plate is connected to the mirror plate via a post.

3. The device of claim 1, wherein the extension plate defines a second gap between the extension plate and the substrate.

4. The device of claim 1, further comprising:

an electrode disposed on another substrate and placed proximate to the extension plate such that a first electrostatic field can be established between said electrode and the extension plate; and

wherein the extension plate defines a third gap between the extension plate and the substrate on which the electrode is disposed.

5. The device of claim 1, wherein the extension plate is on the opposite side of the mirror plate to the substrate.

6. The device of claim 1, wherein the extension plate is electrically conducting.

7. The device of claim 1, wherein the extension plate is dielectric with a dielectric constant larger than 1.0.

8. The device of claim 1, wherein the extension plate is extended beyond the mirror plate.

9. The device of claim 1, wherein the mirror plate is attached to the hinge such that the mirror plate rotates along a rotation axis that is parallel to but offset from a diagonal of the mirror plate when viewed from the top of the substrate.

10. The device of claim 2, wherein the extension plate is spaced from the substrate at a distance the same as that between the hinge support and the substrate.

11. The device of claim 1, further comprising:

a first electrode placed proximate to the extension plate such that a first electrostatic field can be established between the first electrode and the extension plate, and the mirror plate rotates relative to the substrate in response to the first electrostatic field in a first rotational direction.

12. The device of claim 11, further comprising:

a second electrode placed proximate to the mirror plate such that a second electrostatic field can be established between the mirror plate and the second electrode, and the mirror plate rotates relative to the substrate in response to the second electrostatic field in a second rotation direction that is opposite to the first rotation direction.

13. The device of claim 12, wherein the first electrode and the second electrode are on a substrate other than the substrate to which the hinge support is connected.

14. The device of claim 13, wherein the first electrode is on a substrate other than the substrate to which the hinge support is connected; and wherein the second electrode is on the substrate to which the hinge support is connected.

15. The device of claim 14, wherein the second electrode is an electrode film on a surface of the substrate to which the hinge support is connected.

16. A micromirror device, comprising:

a substrate;

a reflective mirror plate connected to the substrate via a hinge and a hinge support and held by the hinge and the hinge support on the substrate; and

an extension plate connected to the mirror plate and connected to the substrate via the mirror plate, the hinge and the hinge support.

17. The device of claim 16, wherein the extension plate defines a first gap between the extension plate and the mirror plate; and wherein the extension plate is connected to the mirror plate via a post.

18. The device of claim 16, wherein the extension plate defines a second gap between the extension plate and the substrate.

19. The device of claim 16, further comprising:

an electrode disposed on another substrate and placed proximate to the extension plate such that a first electrostatic field can be established between said electrode and the extension plate; and

wherein the extension plate defines a third gap between the extension plate and the substrate on which the electrode is disposed.

20. The device of claim 16, wherein the extension plate is on the opposite side of the mirror plate to the substrate.

21. The device of claim 16, wherein the extension plate is electrically conducting.

22. The device of claim 16, wherein the extension plate is dielectric with a dielectric constant larger than 1.0.

23. The device of claim 16, wherein the extension plate is extended beyond the mirror plate.

24. The device of claim 16, wherein the mirror plate is attached to the hinge such that the mirror plate rotates along a rotation axis that is parallel to but offset from a diagonal of the mirror plate when viewed from the top of the substrate.

25. The device of claim 17, wherein the extension plate is spaced from the substrate at a distance the same as that between the hinge support and the substrate.

26. The device of claim 16, further comprising:

a first electrode placed proximate to the extension plate such that a first electrostatic field can be established between the first electrode and the extension plate, and the mirror plate rotates relative to the substrate in response to the first electrostatic field in a first rotational direction.

27. The device of claim 26, further comprising:

a second electrode placed proximate to the mirror plate such that a second electrostatic field can be established between the mirror plate and the second electrode, and the mirror plate rotates relative to the substrate in response to the second electrostatic field in a second rotation direction that is opposite to the first rotation direction.

28. The device of claim 27, wherein the first electrode and the second electrode are on a substrate other than the substrate to which the hinge support is connected.

29. The device of claim 27, wherein the first electrode is on a substrate other than the substrate to which the hinge support is connected; and wherein the second electrode is on the substrate to which the hinge support is connected.

30. The device of claim 29, wherein the second electrode is an electrode film on a surface of the substrate to which the hinge and the hinge support are connected.

31. A micromirror device, comprising:

a substrate;

a hinge and a hinge support connected to the substrate;

a reflective mirror plate attached to the hinge at an attachment point that is located away from a diagonal of the mirror plate when viewed from the top of the substrate; and

an extension plate connected to the mirror plate.

32. The device of claim 31, wherein the extension plate is on the opposite side of the mirror plate to the substrate.

33. The device of claim 31, wherein the extension plate is metallic.

34. A display system, comprising:

a light source;

an array of micromirrors that selectively reflect light from the light source, each micromirror further comprising:

a substrate;

a hinge and a hinge support connected to the substrate;

a movable reflective mirror plate, wherein the hinge is attached to the mirror plate at a first location on the mirror plate; and

an extension plate connected to the mirror pate at a second location on the mirror plate; and

a set of optical elements for directing light from the light source onto the spatial light modulator and projecting the reflected light from the micromirrors onto a display target.

35. The display system of claim 34, wherein the extension plate defines a first gap between the extension plate and the mirror plate; and wherein the extension plate is connected to the mirror plate via a post.

36. The display system of claim 34, wherein the extension plate defines a second gap between the extension plate and the substrate.

37. The display system of claim 34, further comprising:

an electrode disposed on another substrate and placed proximate to the extension plate such that a first electrostatic field can be established between said electrode and the extension plate; and

wherein the extension plate defines a third gap between the extension plate and the substrate on which the electrode is disposed.

38. The display system of claim 34, wherein the mirror plate is on the opposite side of the mirror plate to the substrate.

39. The display system of claim 34, wherein the extension plate is electrically conducting.

40. The display system of claim 34, wherein the extension plate is extended beyond the micromirror plate.

41. The display system of claim 34, wherein the mirror plate is attached to the hinge such that the mirror plate rotates along a rotation axis that is parallel to but offset from a diagonal of the mirror plate when viewed from the top of the substrate.

42. The display system of claim 35, wherein the extension plate is spaced from the substrate at a distance the same as that between the hinge support and the substrate.

43. The display system of claim 34, further comprising:

a first electrode proximate to the extension plate such that a first electrostatic field can be established between the first electrode and the extension plate, and the mirror plate rotates relative to the substrate in response to the first electrostatic field in a first rotational direction.

44. The display system of claim 43, further comprising:

a second electrode proximate to the mirror plate such that a second electrostatic field can be established between the mirror plate and the second electrode, and the mirror plate rotates relative to the substrate in response to the second electrostatic field in a second rotation direction that is opposite to the first rotation direction.

45. The display system of claim 44, wherein the second electrode is an electrode film on a surface of the substrate to which the hinge support is connected.

46. A method of making a micromirror device, the method comprising:
depositing a first sacrificial layer on a substrate;
forming a mirror plate on the first sacrificial layer;
depositing a second sacrificial layer on the mirror plate;
forming a hinge, a hinge support and an extension plate, further comprising:
removing a first portion of the second sacrificial layer at a first location above the mirror plate so as to expose a first portion of the mirror plate; and
depositing the extension plate on the second sacrificial layer and the exposed first portion of the mirror plate; and
removing the first and the second sacrificial layers.

47. The method of claim 46, further comprising:
before forming the extension plate,
depositing a third sacrificial layer; and
forming the extension plate on the third sacrificial layer; and
the step of removing the first and the second sacrificial layers further comprising:
removing the third sacrificial layer.

48. The method of claim 46, wherein the step of forming the hinge, the hinge support and the extension plate further comprises:
removing a second portion of the second sacrificial layer at a second location above the mirror plate so as to expose a second portion of the mirror plate; and
depositing the hinge on the second sacrificial layer and the exposed second portion of the mirror plate.

49. The method of claim 46, wherein the first location is away from a center of the mirror plate.

50. The method of claim 49, wherein the second location is away from a center of the mirror plate.

51. The method of claim 46, wherein the step of removing the first and second sacrificial layer further comprises:

etching the first and second sacrificial layers using a spontaneous vapor phase etching with non-plasma spontaneous chemical vapor-phase etchant.

52. The method of claim 51, wherein the chemical vapor-phase etchant is vapor-phase interhalogen.

53. The method of claim 51, wherein the chemical vapor-phase etchant is vapor-phase noble gas halide.

54. The method of claim 53, wherein the noble gas halide is xenon difluoride.